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if the as yet undetermined A be taken as $k!$.

Another interesting special case is found on treating

$$\frac{A}{(m-k)(m-k+1)\cdots(m-1)m(m+1)\cdots(m+k-1)(m+k)},$$

especially if k be allowed to become infinite (cotangent series).

Also solved by FRANK IRWIN, C. F. GUMMER, S. BEALTY, O. SCHMIEDEL, OLIVE C. HAZLETT, and RALPH KEFFER.

485 (Algebra). Proposed by J. L. WALSH, Madison, Wisconsin.

Is it true that to every convergent series of positive terms, $a_1 + a_2 + a_3 + \cdots$, there corresponds a series of the type

$$\frac{M}{1^p} + \frac{M}{2^p} + \frac{M}{3^p} + \cdots,$$

such that $M/k^p > a_k$, $p > 1$?

SOLUTION BY E. H. MOORE, The University of Chicago.

A convergent series of positive terms, $a_1 + a_2 + \cdots + a_k + \cdots$, is a positive-valued function α; $\alpha(k) = a_k$ $(k = 1, 2, 3, \cdots)$, of the variable positive integer k, satisfying the condition that the corresponding series is convergent. Denote the class of all such functions α by $\mathfrak{C}_+$.

If the question proposed is answered in the affirmative, then there exists a sequence α_n $(n = 1, 2, 3, \cdots)$ of functions α_n of the class $\mathfrak{C}_+$, viz., the sequence of functions

$$\alpha_n : \alpha_n(k) = \frac{n}{k^{1+(1/n)}} \quad (k = 1, 2, 3, \cdots),$$

of such a nature that every function α of the class $\mathfrak{C}_+$ is dominated by a suitably chosen function α_n of the sequence, viz., $|\alpha(k)| \leqq |\alpha_n(k)|$ $(k = 1, 2, 3, \cdots)$,—that is, the class $\mathfrak{C}_+$ has the dominance property D_2 defined (for the general class of real-valued functions on the general range) in § 22 of my *Introduction to a Form of General Analysis* (The New Haven Mathematical Colloquium, Yale University Press, 1910, p. 41).

Now I have proved (§ 23*c* (5), *loc. cit.*) that the class $\mathfrak{M}^{\mathrm{III}_1}$ (and, a fortiori, the class $\mathfrak{C}_+$) of all absolutely convergent series of real-valued terms fails to have the dominance property D_2. Hence, the question proposed must be answered in the negative.

The proposition cited is one of a number of theorems involving various dominance properties. The present question may be answered still more luminously by citing the theorem of Hadamard (Acta Mathematica, vol. 18, 1894, p. 328, theorem (β); cf. also *loc. cit.*, p. 49) that for every sequence (α_n) of functions of the class $\mathfrak{C}_+$ such that for every k $\alpha_n(k)$ increases with n there exists a function α of the class $\mathfrak{C}_+$ of such a nature that for every n

$$\lim_{k=\infty} \frac{\alpha_n(k)}{\alpha(k)} = 0.$$

Also solved by ELIJAH SWIFT.

486 (Algebra). Proposed by FLORENCE P. LEWIS, Baltimore, Md.

Find the condition which must be satisfied by the coefficients of the quartic

$$a_0x^4 + a_1x^3 + a_2x^2 + a_3x + a_4 = 0$$

in order that the equation be solvable by successive applications of the quadratic formula.

SOLUTION BY THE PROPOSER.

The equation must be of the form $A(ax^2 + bx + c)^2 + B(ax^2 + bx + c) + C = 0$ or $Ay^2 + By + C = 0$. Let x_1 and x_1' correspond to root y_1, and x_2 and x_2' to root y_2, respectively. We then have $x_1 + x_1' = -b/a$ and $x_2 + x_2' = -b/a$. This says that the line joining x_1 and x_1' is bisected at $-b/2a$, or that x_1 and x_1' are harmonic conjugates as to $-b/2a$ and ∞. The same